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Ms. Marlene H. Dortch
Secretary
Federal Communications Commission
445 Twelth Street, N.W.
Washington, DC 20554

Re: ET Dkt. 01-278 – *Ex Parte Presentation*

Dear Ms. Dortch:

On behalf of Savi Technology, I am submitting the attached analysis of the potential for interaction between amateur portable units and radio frequency identification systems that would operate under the rules proposed in this proceeding. The analysis, which was prepared by Eugene Robinson on behalf of Savi, follows up on an FCC staff inquiry to Savi as to the likely effects, if any, of emissions from RFID tag readers on amateur operations. Mr. Robinson is a registered professional engineer in Texas and a senior member of the IEEE.

Should any questions arise concerning this matter, please contact this firm's engineering advisor Thomas Dombrowsky at 202-719-7236.

Respectfully,

/s/ *David E. Hilliard*

David E. Hilliard

Attachment

cc (w/ attachment): Mr. Julius Knapp, Mr. Hugh Van Tuyl

RFID and FM Repeater
Analysis

The ARRL has expressed concerns that the Savi RFID system would cause interference to amateur FM repeater operations. Rather than continuing to debate ARRL on methodology, Savi Technology has now used the ARRL analysis methodology to compute the FM repeater signal levels at the repeater edge of coverage as determined by the line-of-sight distance (LOS) and the RFID interrogator/tag signals at a distance representative of a commercial shipping environment. These signal levels were then used to derive the C/(N+I) ratios. The accompanying analysis shows that harmful interference to the amateur FM repeater operations would not occur. These conclusions have been verified through actual test using the Savi RFID system and typical amateur FM handheld equipment and repeaters.

This analysis computes the edge of coverage (line-of-sight, LOS) for a 25 watt repeater signal and the RFID signal at 1 Km (a distance representative of the separation between commercial and residential sites) to determine the desired signal C/(N+I) ratio. Using the same methodology as the ARRL the RFID signal proposed by the rulemaking and as measured at 3 meters is first used to determine the RFID transmit power levels. Then at the repeater edge of coverage the average and peak RFID power levels as proposed by the rulemaking are then used to compute the C/(N+I) ratios when located 1 Km from the RFID interrogator source. The C/(N+I) ratios are also computed for a distance of 10 meters to support the results of operational test that verified amateur receiver reception capability when operated near a RFID system.

The 25-watt repeater may have antenna heights ranging from 20 to 200 feet. These heights will result in repeater coverage distances that produce LOS received signal levels in the range of –89 dBW to –99.4 dBW.

The Savi RFID interrogator has average field intensity measured at 3 meters of 11,000 microvolts per meter. With a 10 percent duty factor, (10 millisecond transmit in a 100 millisecond interval) the peak field intensity is 110,000 microvolts per meter at 3 meters. The RFID tags have an average field intensity of 4,398 microvolts per meter at 3 meters and 43,980 microvolts per meter at 3 meter peak with a 10 percent transmit duty factor. This analysis computes the larger RFID interrogator transmit power using the field intensity measured at 3 meters. Then that result is used to determine the RFID signal level at a distance of 1 Km. The FM receiver desired signal (C) and the unwanted signal (I) is used to derive the C/(N+I) ratio and determine receiver performance.

Converting the RFID interrogator 11,000 microvolts per meter field intensity measurement at 3 meters to power using

$$P(mW) = \frac{1.89972x10^{-8} E^2}{f^2}$$ where E is microvolts per meter and f is in MHz.

$$P(mW) = \frac{1.89972x10^{-8}(11{,}000)^2}{(433.92)^2} = 1.22x10^{-5}\,mW$$

A peak field intensity of 110,000 microvolts per meter at 3 meters yields the peak power level of 1.22 x 10^{-3} mW.

The following equation is used to determine the transmit power level when the received power level and distance from the source is known.

$$P_t = \frac{16\pi^2 r^2 P_r}{G_r G_t \lambda^2}$$

This equation yields an average interrogator transmit power of 3.6419 x 10^{-2} mW or – 44.38 dBW and a peak interrogator power of 3.64 mW or –24.4 dBW with a 10 percent duty cycle. Rearrangement of the above equation yields an equation that can be used to determine the received power level 1 Km from the interrogator.

$$P_r = \frac{G_r G_t P \lambda^2}{16\pi^2 r^2}$$

The average power level received from the RFID interrogator is –129.59 dBW at 1 Km and the peak power level received is –109.59 dBW.

The resulting C/(N+I) ratios at the edge of repeater coverage for the average transponder power levels range from 30 to 20 dB (-129.59 dBW vs –89 to 99 dBW for the repeater) and 20 to 10 dB for peak transponder power levels (-109.59 dBW vs –89 to 99 dBW for the repeater). The ARRL Handbook for the Radio Amateur states, "The loudest signal received, even if it is only two or three times stronger than other stations on the same frequency, will be the only transmission demodulated". Levels differences of two or three times are in the range of 3 dB to 5 dB

Tests with handheld FM receivers at distances less than 10 meters have shown that the RFID interrogator signals will not break the FM receiver squelch. These tests have also verified that when receiving desired signals the FSK RFID signal is not detected. The received RFID signal level at 10 meters for the average transmitted power is –89.59 dBW and for the peak transmitted power is –69.59 dBW. This results in C/(N+I) ratios of –0.6 dB to –9.8 dB for the average power received and –19.4 dB to –29.8 dB for the peak power level received at the 10 meter distance. Further investigation of receiver design indicates that the FM receiver limiter and discriminator stages eliminate signals that appear as impulse noise. In addition the de-emphasis 2 to 2.5 kHz low-pass audio processing circuits greatly attenuate noise and signals that are outside of the voice frequency range. The average and peak levels shown above and the operational test performed indicate that harmful interference with amateur FM receivers does not and will not occur.